that the terminal lobation is most clearly shown. A comparison of this figure with the numerous specimens of *Liriodendropsis simplex* of Newberry leaves no doubt whatever that the Portuguese plant is at least a congener of the American plant, and it is just possible that it may belong to the same species. As this form has been three times published* it is a little surprising that Saporta did not think to compare it with the Portuguese plant. There are differences in the finer nervation, but this is also perceptible between his two drawings of the same specimen; these also differ in different specimens of the American plant, and one or two other species remain to be published. When all the material is illustrated most of these differences will disappear. If any remain it can be ascribed to difference of age and geographical position.

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Washington.

EXPLANATION OF ACQUIRED IMMUNITY FROM INFECTIOUS DISEASES.†

It has long been known that, in a considerable number of infectious diseases, a single attack, however mild, affords protection against subsequent attacks of the same disease; that in some cases this protection appears to be permanent, lasting during the life of the individual; that in others it is more or less temporary, as shown by the occurrence of a subsequent attack.

The protection afforded by a single attack not only differs in different diseases, but in the same disease varies greatly in different individuals. Thus certain individuals have been known to suffer several attacks of small-pox or of scarlet fever, although, as a rule, a single attack is protective. Exceptional susceptibility or insusceptibility may be not only an individual but a family characteristic, or it may belong to a particular race.

In those diseases in which second attacks are not infrequent, as, for example, in pneumonia, in influenza or in Asiatic cholera, it is difficult to judge from clinical experience whether a first attack exerts any protective influence. But from experiments upon the lower animals, we are led to believe that a certain degree of immunity, lasting for a longer or shorter time, is afforded by an attack of pneumonia or of cholera, and probably of all infections due to bacterial parasites. In the malarial fevers, which are due to a parasite of a different class, one attack affords no protection, but rather predisposes to a subsequent attack.

In those diseases in which a single attack is generally recognized as being protective, exceptional cases occur in which subsequent attacks are developed as a result of unusual susceptibility or exposure under circumstances especially favorable to infection. Maiselis has recently (1894) gone through the literature accessible to him for the purpose of determining the frequency with which second attacks occur in the various diseases below mentioned. The result is as follows:

	Second Attacks.	Third Attacks.	Fourth Attacks.	Total.
Small-pox . .	505	9	0	514
Scarlet fever .	29	4	0	33
Measles . . .	36	1	0	37
Typhoid fever .	202	5	1	208
Cholera . . .	29	3	2	34

Recent researches indicate that the principal factor in the production of acquired immunity is the presence, in the blood of the immune animal, of some substance capable of neutralizing the toxic products of the particular pathogenic microörganism

* Bull. Torr. Bot. Club, Vol. XIV., New York, Jan. 1887, p. 6, pl. lxii, figs. 2, 3, 4; Am. Journ. Sci., Vol. XXXIX., New Haven, February, 1890, p. 98, pl. ii., figs. 6, 7; Trans. N. Y. Acad, Sci., Vol. XI., 1892, p. 102, pl. ii., figs. 2–7, 9.

† Abstract of a paper read before the Biological Society of Washington, March 9, 1895.

against which immunity exists, or of destroying the germ itself.

The substances which destroy the toxic products of pathogenic bacteria are called antitoxins. As pointed out by Buchner in a recent paper, the antitoxins differ essentially from the so-called alexins, to which natural immunity is ascribed. The alexins are characterized by their germicidal and globulicidal action—they destroy both the red corpuscles and the leucocytes of animals belonging to a different species from that from which they have been obtained, and by their coagulability and instability — destroyed by sunlight and by a temperature of 50° to 55° C. On the other hand, the antitoxins best known (diphtheria and tetanus) have no germicidal or globulicidal action; they resist the action of sunlight and require a temperature of 70° to 80° C. for their destruction.

Our knowledge of the antitoxins dates from the experiments made in the Hygienic Institute of Tokio, by Ogata and Jasuhara, in 1890. These bacteriologists discovered the important fact that the blood of an animal immune against anthrax contains some substance which neutralizes the toxic products of the anthrax bacillus.

In the same year (1890) Behring and Kitasato discovered that the blood of an animal which has an acquired immunity against tetanus or diphtheria, when added to a virulent culture of one or the other of these bacilli, neutralizes the pathogenic power of such cultures, as shown by inoculation into susceptible animals. And also that cultures from which the bacilli have been removed by filtration, and which kill susceptible animals in very small amounts, have their toxic potency destroyed by adding to them the blood of an immune animal, which is thus directly proved to contain an antitoxin which comparative experiments show not to be present in the blood of non-immune animals.

During the past two or three years numerous additional experiments have been reported which confirm the results already referred to, and show that immunity may be produced in a similar manner against the toxic products of various other pathogenic bacteria—the typhoid bacillus, the 'colon bacillus,' streptococcus pyogenes, staphylococcus pyogenes aureus and albus, etc.

The Italian investigators, Tizzoni and Centanni, in 1892, published a preliminary communication in which they gave the results of experiments which appear to show that in guinea-pigs treated with tuberculin, by Koch's method, a substance is developed which neutralizes the pathogenic potency of the tubercle bacillus. Professor Tizzoni and his associate, Dr. Schwarz, have also (1892) obtained evidence that there is an antitoxin of rabies. Blood-serum taken from a rabbit having an artificial immunity against this disease was found to neutralize, *in vitro*, the virulence of the spinal marrow of a rabid animal after a contact of five hours.

Professor Ehrlich, of Berlin, in 1891, published the results of some researches which have an important bearing upon the explanation of acquired immunity, and which show that susceptible animals may be made immune against the action of certain toxic proteids of vegetable origin, other than those produced by bacteria; also that this immunity depends upon the presence of an antitoxin in the blood-serum of the immune animals.

The experiments of Ehrlich were made with two very potent toxalbumins—one ricin, from the castor-oil bean; the other, abrin, from the jequirity bean. The toxic potency of ricin is somewhat greater than that of abrin, and it is estimated by Ehrlich that 1 gm. of this substance would suffice to kill one and a half million of guinea-pigs. When injected beneath the skin in dilute solution it produces intense local inflammation, resulting in necrosis. Mice are

less susceptible than guinea-pigs, and are more easily made immune. This is most readily accomplished by giving them small and gradually increasing doses with their food. As a result of this treatment the animal resists subcutaneous injections of 200 to 300 times the fatal dose for animals not having this artificial immunity.

Ehrlich gives the following explanation of the remarkable degree of immunity established in his experiments by the method mentioned:

"All of these phenomena depend, as may easily be shown, upon the fact that the blood contains a body—antiabrin—which completely neutralizes the action of the abrin, probably by destroying this body."

In a later paper (1892) Ehrlich has given an account of subsequent experiments which show that the young of mice which have an acquired immunity for these vegetable toxalbumins may acquire immunity from the ingestion of their mother's milk; and also that immunity from tetanus may be acquired in a brief time by young mice through their mother's milk.

A most interesting question presents itself in connection with the discovery of the antitoxins. Does the animal which is immune from the toxic action of any particular toxalbumin also have an immunity for other toxic proteids of the same class? The experimental evidence on record indicates that it does not. In Ehrlich's experiments with ricin and abrin he ascertained that an animal which had been made immune against one of these substances was quite as susceptible to the toxic action of the other as if it did not possess this immunity, *i. e.*, the anti-toxin of ricin does not destroy abrin, and *vice versa*.

We have also experimental evidence that animals may acquire a certain degree of immunity from the toxic action of the venom of the rattlesnake. This was first demonstrated by Sewall (1887), and has been recently confirmed by Calmette (1894). In his paper detailing the results of his experiments the author last named says:

"Animals may be immunized against the venom of serpents either by means of repeated injections of doses at first feeble and progressively stronger, or by means of successive injections of venom mixed with certain chemical substances, among which I mention especially chloride of gold and the hypochlorites of lime or soda.

"The serum of animals thus treated is at the same time preventive, antitoxic and therapeutic, exactly as is that of animals immunized against diphtheria or tetanus.

"If we inoculate a certain number of rabbits, under the skin of the thigh, with the same dose, 1 millgr. of cobra venom, for example, and, if we treat all of these animals, with the exception of some for control, by subcutaneous or intraperitoneal injections of the serum of rabbits immunized against four millgrs. of the same venom, all of the control animals not treated will die within three or four hours, while all of the animals will recover which receive 5 c. c. of the therapeutic serum within an hour after receiving the venom."

As a rule the antitoxins have no bactericidal action; but it has been shown, by the experiments of Gamaleïa, Pfeiffer and others, that in animals which have an acquired immunity against the spirillum of Asiatic cholera and against spirillum Metchnikovi there is a decided increase in the bactericidal power of the blood-serum, and that immunity probably depends upon this fact.

Certain important questions present themselves in connection with the production of antitoxins and germicidal substances in the blood of immune animals, one of which is: Is the production of the antitoxin continuous while immunity lasts, or does it occur only during the modified attack which results from inoculation with an attenuated virus, or of filtered cultures, the antitoxin being subsequently retained in the circulating blood? The latter supposition does not appear very plausible, but it must be remembered that these antitoxins do not dialyze—*i. e.*, they do not pass through ani-

mal membranes—and consequently would not readily escape from the blood-vessels, notwithstanding the fact that they are held in solution in the circulating fluid. On the other hand, the passage of the tetanus antitoxin into the mother's milk would indicate a continuous supply, otherwise the immunity of the mother would soon be lost. Further experiments are required to settle this question in a definite manner, and also to determine the exact source of the antitoxins in the animal body and the *modus operandi* of their production.

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REMARKING THE MEXICAN BOUNDARY.

MR. A. T. MOSMAN, assistant in the U. S. Coast and Geodetic Survey, one of the commissioners on the part of the United States, presented an interesting summary of the work at a meeting of the National Geographic Society in Washington on the 8th inst.

At the initial meeting of the commissioners for the two countries, it was agreed that any of the old monuments recovered should be taken as defining the line; that new monuments should be interpolated between them, so that no two monuments should be more than 8000 metres apart, as required by the new treaty. The line had been marked under the treaty of 1853, by 52 monuments; the commissioners found 38 of these standing in 1891. On the parallels the new monuments mark the curve of the parallel, but on the oblique lines the monuments recovered were not accurately located on the line joining their extremities, and the boundary on these lines as now marked is, therefore, a broken line. Old monuments were recovered at all important points on the boundary, including all points where the line changed direction, but the distances between them were unequal, and in one instance exceeded 100 miles. The line from El Paso on the Rio Grande to San Diego on the Pacific, 700 miles, is now defined by 258 monuments.

The field work required the redetermination of the geographic positions of the old monuments recovered, and presents some interesting comparisons showing the facility and certainty of modern methods. The longitudes of the old monuments were determined by Emory from transits of the moon and moon culminating stars. In the relocation the longitudes were determined by the telegraphic method, connected with the geodetic work of the Coast Survey by coast survey parties working in conjunction with the commissioners. The greatest difference developed from Emory's positions was 4′ 34″.3 with other differences of 34″ and 54″ and still smaller quantities showing the old work to have been remarkably good for the method. The latitude stations in the new work were about 20 miles apart over the whole line, and at each station an azimuth was observed on Polaris near elongation to start the direction for the new tangent for the parallel and check the tangent ending at the station. The latitude observations were made with the zenith telescope formerly used on the N. W. boundary, but improved with new micrometer and levels. The telescope has a focal length of 826 mm., and the objective a clear diameter of 67 mm. A new departure was made in mounting the instrument on a wooden pier constructed in a simple form, readily transported. Its stability proved as great as a brick or stone cemented pier, as it was not uncommon to secure a whole night's work without relevelling, and the instrument invariably remained for several hours with level correction less than one div.=1″.28. The probable errors of the latitude determinations from the U. S. observers = ± 0″.03 to 0″.4. The Mexican observations have not yet been received. The plan of operations agreed upon required